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Centralized versus Decentralized
Computer Systems: A New Approach to
Organizational Impacts

Ada Barbara Demb

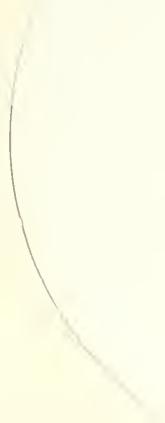
CISR REPORT 12

SLOAN WP 818-75

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Center for Information Systems Research

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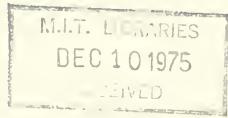
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Centralized versus Decentralized Computer Systems: A New Approach to

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The debate over the relative merits of centralized computer systems and decentralized systems has raged for at least fifteen years. Recent developments in computer technology have fueled the debate anew. The dramatic impact of the mini-computer as well as improvements in telecommunications have added new dimensions to the controversy. According to a survey in the spring of 1975 "the use of minicomputers versus larger mainframes is by far the major interest of DP personnel."¹

Evaluations of alternative configurations have tended to focus on three primary criteria: (1) the economics of the system, (2) the ability of the system to generate timely and useful information, i.e. the effectiveness of the system, and (3) the consequences vis-a-vis the management and structure of the organization, i.e., the organizational impacts of the system.

While measurements of economics and effectiveness are complex, it appears that judgments in these areas can be quantified and thus assessed to a far greater degree than the organizational impacts of various systems. It is this last criteria which is the focus of this paper: the development and presentation of a framework for assessing organizational impacts of computer systems.

For those considering centralized data processing systems these issues are of particular concern. Centralized DP systems appear to offer significant economic advantages over other configurations. However, historically the implementation of centralized systems has caused disruptions in organizations thereby discouraging

* The full report of this study is available through the Center for Information Systems Research, M.I.T.: "The Organizational Impacts of Computer-Based Information Systems: An Organization Development Approach and Case Study of Centralized Systems in Higher Education".

¹ Computer World IX (20), May 14, 1975, page 1.

choice of this alternative in many instances.

In addition to developing a framework for assessing organizational impacts, it is the purpose of this report to demonstrate to management that the effectiveness of computer-based information systems - of whichever configuration - can be improved by top management action directed toward a set of contingencies which determine organizational impacts. The framework discussed below presents a comprehensive approach for assessing the organizational impacts of computer systems.

The Approach

There is already a great deal of expert opinion recorded on the organizational issues of computer-based information systems. However, much of the opinion consists of general statements about issues considered at the most macro levels of abstraction. We will explore these opinions and then present an alternative approach.

In my view, a focus on organizational impacts involves four major considerations: (1) the functions of the EDP operation itself; (2) the nature of the development effort for application systems for management; (3) the relationships among The DP department and other departments in the organization; (4) the impacts of the DP development effort on the people who interact with the management systems.

The development of such an approach is a complex process, as no one field of research addresses an entire range of the issues effectively. This study draws on two major fields of research and examines the on-going experience of an organization currently centralizing its computer-based management systems. It is divided into four major sections:

- I. Expert Opinion as Recorded in the Information Systems Literature
- II. Organization Development: A Framework for Responding to Organizational Impacts
- III. Field Study of Centralization: An Example from Higher Education
- IV. General Implications for Management

I. Expert Opinion as Recorded in the Information Systems Literature

In addition to the literature which discusses the question of centralization and decentralization directly, there are two other segments of the literature which are useful for our purposes: discussions of the overall effects of computerization on organizations and on management, in particular; and research in the process of implementing computer systems.

A review of these three segments of the literature generates a series of predictions by experts in the field. The predictions are presented in Exhibit I-1. With regard to the exhibit, two points should be noted. (1) Although each prediction is attributed to one or two authors, numbers of writers have opinions on most topics. Some articles, especially those regarding centralized systems, are summary works which have been noted for the reader's convenience, and which are most cited. (2) The predictions are presented as positive statements throughout the exhibit; the words "will" and "are" characterize the statements. Most predictions, however, are still the subject of some controversy, and several have come to be accorded increasingly less credence over the past fifteen years. All are presented in this exhibit to outline the scope of the territory to be addressed by an alternative approach. They serve as a foil for the discussion which follows.

Exhibit I-1: Predictions Identified in the Information Systems Literature

In general, the development of effective computer-based information systems,

1. Will be hindered by present organization norms. (Argyris, 1971)
2. Will create high levels of anxiety and tension among affected management. (Argyris, 1971)
3. Will exhibit growth stages for which specific problems can be identified. (Gibson and Nolan, 1973)
4. Will significantly shift the distribution of power in organizations. (Lucas 1973; Whisler, 1970)
5. Will have greater impacts on organization processes and delegation of authority than on formal structure. (Hofer, 1970)

6. Will have greater impacts on organization components whose principal tasks involve the processing of large amounts of quantitative data, than on components whose tasks do not. (Hofer, 1970)
7. Are usefully categorized into the three management functions which they support: operational control, management control and strategic planning. (Anthony, 1965; Dearden, 1966; Gorry and Scott Morton, 1971)

For management and management decision-making, computer-based information systems,

8. Will limit and constrain the creativity and scope of middle-level management jobs. (Leavitt and Whisler, 1958)
9. Will prove more or less useful for decisions depending on the nature of the decisions, i.e. programmed and unprogrammed; and tend to offer the greatest potential for the support of unprogrammed decisions. (Gorry and Scott Morton, 1971)
10. Will result in delegation of management control functions by top management, permitting more attention to strategic planning activities. (Hofer, 1970)

Effective implementation of computer-based information systems is determined by,

11. Education provided to all involved parties. (Heany, 1972; Urban, 1972)
12. The level of top management support. (McKinsey & Co., 1968)
13. The degree of operating management involvement. (McKinsey & Co., 1968)
14. Organizational contingencies, such as the stage of an organization in its life cycle. (Rubenstein et al., 1967)
15. Attitudes toward and perceptions of computer systems which users have developed as a result of prior experience with EDP systems. (Lucas, 1973)
16. The amount of the user's time he or she believes is necessary for development of the system. (Manley, 1973)
17. The existence of well-defined and measurable objectives. (Huysmans, 1973)
18. The number, distribution, and position with respect to authority structures of professionals in the organization. (Schein, 1970)

Centralized computer-based information systems result in,

19. A tendency to centralize authority and decision-making. (Whisler, 1970)
20. A tendency for the level of professionalization in the organization to limit the centralization of authority and decision-making. (Whisler, 1970)
21. Loss of authority, control over job inputs, and the ability to innovate on the part of local management. (Norton, 1973)
22. The organization becoming more rigid and inflexible. (Whisler, 1970)
23. Negative responses to the system on the part of local management. (Passim)

24. Vastly increased communication and coordination difficulties associated with staff and software development. (Norton, 1973)
25. A decrease in the level of local incentive and job satisfaction. (Whisler, 1967)
26. Clear economics of scale. (Canning, 1973; Norton, 1973)
27. Higher costs in the event of system failure. (Canning, 1973; Streeter, 1973)
28. Increased problems associated with data security, if the data base is centralized. (Canning, 1973)
29. Attraction of better quality computer personnel, who will be more satisfied working in groups of like professionals and whose level of sophistication will increase with the interaction. (Norton, 1973)
30. Efficiency in program development; homogeneity among sub-units will increase the level of efficiency. (Glaser, 1973; Norton, 1973)
31. Disruptions caused by the standardization of software development.
32. Inadequate response by a centrally-located computer staff to local needs and priorities. (Glaser, 1973)

Although the list of predictions appears to cover quite a range of topics, there are several problems associated with it. A major inadequacy is the lack of documentation for most predictions. In addition, the experts offer few guidelines for rank-ordering the issues; there is no mechanism for systematizing the predictions. Thus, we are confronted with an array of issues and concerns which can only be mastered by memorization and which are apparently of relatively equal importance. Information systems research offers neither theory nor model with which to structure these statements. As a result, it is difficult for management to take steps in any organized manner to ameliorate the disruptions of major systems changes, or of centralization in particular.

II. Organization Development: A Framework for Responding to Organizational Impacts

Organization development theory (OD) is one of several major frameworks available for analyzing organizations and organization dilemmas. Using theories from human behavior and human development it provides an analytic approach comprised of a series of dimensions which describe the ongoing dynamics within an organization. It is also a normative theory which describes effective organization

and thus sets certain behavioral and structural goals for a change process.

Both the analytic approach and the normative theories have two major foci: the individual and groups of individuals.

Two researchers in the field of information systems suggest OD is a particularly appropriate analytic framework for EDP system impacts.

Effective management of computer resources requires attention to more than the formal devices and tasks and ongoing operations in a steady state. The MIS manager and senior management must conceive of this job as managing a resource that is a change agent. As such, attention must be paid to an analysis of informal and behavioral forces that emerge as sources of resistance or support when change is contemplated, and to the opportunities for modification of organizational structure and control devices as means to achieve change goals . . . (Gibson and Nolan, 1973, p. 2, emphasis added)

The major assumptions about human behavior on which organization development theories and concepts are based are those expressed by Douglas MacGregor in The Human Side of Enterprise:

1. The average human being does not inherently dislike work, and may derive satisfaction from it.
2. Man will exercise self-direction and self-control in the service of objectives to which he is committed.
3. Commitment to objectives is a function of the reward associated with their achievement. The most significant of such rewards, e.g., the satisfaction of ego and self-actualization needs, can be direct products of efforts directed toward organizational objectives.
4. The average human being learns, under proper conditions, not only to accept but to seek responsibility.
5. The capacity to exercise a relatively high degree of imagination, ingenuity and creativity in the solution of organization problems is widely, not narrowly, distributed in the population.
6. Under the conditions of modern industrial life, the intellectual potential of the average human being is only partially utilized.

(MacGregor, 1960, pp. 47-48)

The concepts and models from this field are a rich and as yet, barely tapped resource with which to build a systematic approach to the organization issues of EDP development. Organization development provides the basis for an approach which encompasses the four dimensions of those impacts noted above.

An OD approach first directs attention to the distinction of two major aspects of an EDP development effort:

- (a) it identifies a process of planned organization change,
- (b) it identifies an organization sub-unit which interacts with other organization sub-units and members.

The discussion which follows is similarly divided into two major sections: a discussion of Planned Change, and a section on Internal Organization Dynamics.

A. Planned Change

One widely-used model for organization change was developed for consultants (Kolb and Frohman, 1970). Presented in Exhibit I-2, it describes an iterative, seven-stage process and identifies specific issues whose resolution have been demonstrated to be necessary for the successful completion of each stage. The object of this complex process is a change which accurately addresses organization needs and which is actively accepted by those it affects.

The seven stages are:

Scouting - a period during which a consultant and a potential client become acquainted and determine the appropriateness of a contract based on an evaluation of needs and expertise. (This is not relevant for our purposes.)

Entry - the process of developing a relationship between the change agent and the organization. At stake here is the establishment of a collaborative relationship. Collaboration is a critical aspect of the OD development model. Collaboration implies interdependence, where the interdependence is based on mutual need satisfaction and mutual influence. It is this aspect of the change effort which is necessary for organization members to "own" the change and to invest in maintaining the results of the change.

Diagnosis - the feasibility study or assessment of organization needs. It is primarily a data-gathering and problem-definition process conducted jointly by staff and user.

Planning - the time for setting specific goals and time-tables. Alternative

courses of action are designed, evaluated, and a choice made. During this stage criteria are also developed for later evaluation of the change results. The key aspect of this phase is the direct involvement of the people who will be held responsible for implementing the new operation.

Action - the implementation stage. In this model it is characterized by high levels of information exchange, training and communication among all parties.

Evaluation - for a consultant this is a discrete phase; for a computer operation and user group it should be the scheduled evaluation of the system against originally agreed-upon objectives. Inadequacies should signal a second iteration of Diagnosis, Planning and Action on specific problems.

Termination - for non-consultive purposes this stage has limited application. It speaks primarily to an assessment of organizational mechanisms for maintaining the change: the institutionalization of the new system.

Exhibit I-2: Summary of change Model and Issues, with Relevant Predictions

Stage	Issue	Predictions from Exhibit I-1
Scouting	Initial evaluations of needs vs. expertise	
Entry	Development of collaborative relationship Establishment of commitment levels Responsibilities designated Initial Priority setting Contracting	16, User's time
Diagnosis	Data-gathering Joint definition of organization needs and likely responses	13, Operating management involvement 14, Organizational contingencies
Planning	Formal goal-setting Time-tables set Alternative plans evaluated, Choice made Evaluation criteria determined for later use	17, Well-defined, measurable objectives
Action	Implementation stage Education Feedback Communication	11, Education
Evaluation	Assessment of effort in terms of previously agreed-upon criteria and new Diagnosis	17, Well-defined, measurable objectives
Termination	End of consulting relationship	
Throughout:	Top management support General level of stress	12, Top management support 2, Anxiety and tension

The model presented here advocates in general, that successful change is based on collaboration among all involved parties, both in assessing needs and executing a plan of action. The most critical stage appears to be Entry, during which period those involved in the change explicitly establish commitment levels, assign responsibilities, set priorities, and contract the specifics of the collaborative venture.

In addition to the issues listed with the stages, most practitioners agree that major organizational changes are highly stressful activities, and that visible and specific top management support is integral to the success of such an effort. As might be expected the model complements the issues raised by the predictions from the MIS literature which deal with implementation. These are noted in the right column of Exhibit I-2.

With the exception of prediction 2, which deals with the level of tension and anxiety management will experience, all of the MIS predictions noted in Exhibit I-2 are drawn from the implementation literature. The change model provides a framework within which to organize and interrelate the predictions noted. In addition, the model outlines a much more comprehensive set of issues, and identifies those most critical for success: entry and diagnosis. It not only provides a guideline for planning change, but also a means of diagnosing an ongoing effort so that specific remedial steps can be taken in the event of difficulties. This comprehensiveness and diagnostic capability are the strengths of the change model.

B. Internal Organization Dynamics

Descriptions and analyses of the relationships between an EDP group and the rest of an organization revolve around a less orderly set of issues than the change model. Much like analyzing the dynamics of a marching band, the observer is confronted not only with persons and music, but also with carefully choreographed and highly interdependent movement. Any change, such as the introduction of a new rhythm, can cause immense disruption and confusion.

Organization development theory provides three elements around which to

organize issues of organization impact: (a) the characteristics of the actors involved, both individuals and groups; (b) the nature of the interactions among these actors; and (c) the content of the interaction. Each is discussed at length in the full report, and a summary is presented below. To illustrate concepts, individuals and group specifics have been drawn from the field study site, a multi-campus public college system.

(a) Characteristics of Actors

In an institution of higher education, a multi-campus institution with centralized data processing facilities, nine actors can be identified.

Individuals

- (1) Central DP staff
- (2) Local DP staff
- (3) Central administrators (Chancellor's office)
- (4) Local campus administrators

Groups

- (5) Central DP department
- (6) Local campuses
- (7) Entire campus system (the larger organization)
- (8) The environment of the organization
- (9) Faculty

Characteristics of specific actors differ widely. In any organization, for example, data processing personnel view the world in a markedly different manner than do managers. Local administrators have different attitudes and priorities than central administrators. However, there are sets of characteristics which inhere generally to individuals in organizations, and there are characteristics which inhere generally to groups of individuals, i.e., departments.

Exhibit I-3 presents a set of principles which tend to be accepted as characteristics of actors in organizations and groups. A few apply specifically to higher education; these are self-evident. Predictions from the MIS literature which are

addressed by the principles are also noted.

(b) Interactions Among Actors

In this same university setting ten interactions can be identified -- excluding those which involve the faculty. Faculty who are also administrators are considered in that group.* The interactions are between:

- (1) Central and local DP staff
- (2) Central DP staff and local administration
- (3) Local DP staff and local administration
- (4) Central DP staff and central administration
- (5) Central and local administration
- (6) Campuses and the DP department
- (7) Campuses and the larger organization
- (8) Central DP department and the larger organization
- (9) Campus and campus
- (10) Larger organization and its environment

It is the nature of the interaction itself which is the focus of this portion of the discussion. Research in organizations has surfaced principles which pertain to certain types of interactions, several of which are represented in this list. Awareness of the general nature of some of the interactions permits anticipation of response by participants in organizations whose situations fit them.

For example, interactions (1), (2), and (3) share a tendency to be highly interdependent. The central data processing staff is dependent upon the local data processing coordinator for feedback; the local DP coordinator is dependent upon the central staff for service. Local administrators are dependent upon the central DP staff for application program development; central DP staff are dependent

*As this study focuses on management systems, reference to faculty are limited to those who act in administrative capacities. Teaching and research support provided by computer-based systems are excluded from this discussion.

Exhibit I-3: Summary of Concepts Pertaining to Actors

Actors/Concepts

Individuals

Increase in job satisfaction tends to increase as the amount of control an individual experiences in his job increases
Threat to certain personal needs will produce varying but predictable levels of anxiety and tension.

There is a high likelihood of relatively intense reaction to a change which appears to significantly threaten autonomy / control.

EDP Staff

EDP tend to view themselves as "professionals" or "experts" and share the values associated with these views.

Marked differences in perception and difficulties in communication are likely to occur in a situation where manager and EDP staff must collaborate.

Administrators--Local/Central

Local and central administrators will experience different loyalties and priorities; one to the campus, the other to larger organization.

In higher education, middle level administrators are caught in a professional sandwich between upper level administrators and the employees--faculty.

*See Exhibit I-1, pp. 3-5.

Predictions from MIS Literature*

21, Local loss of autonomy (centralized EDP)
23, Negative response to centralized EDP

2, Anxiety and tension
3, EDP stages and problems
8, Middle-management scope/creativity
21, above
23, above

4, Distribution of power shifted
8, 21, 23 directly above
25, decrease Local incentive/satisfaction (centralized)
-13-

6, Differential EDP impact on management
10, Top management delegation
8, above
14, Organizational contingencies
18, Distribution of professionals

Exhibit I-3: Continued

Actors/Concepts

Groups

EDP Staff and the Campuses

Understanding the norms and objectives of a department or group is a key to anticipating likely responses of that department to a given situation.

"Professional" groups will have different norms and objectives than "non-professional" groups.

Larger Organization/Entire Campus System

Management prerogatives with regard to access to information abound in the university setting.

The Environment

Information needs, determined in large part by the environment, tend to dictate organization structure.

The external environment of the university is extremely complex.

Predictions from MIS Literature

-14-

14, Organizational contingencies

29, Centrally located staff
31, Standardization disruptions
32, Responses to local needs/
priorities

4, Distribution of power shifted
14, Organizational contingencies

14, Organizational contingencies

upon local administrators to provide specifications for these programs.

Local DP staff and local administrators are also highly interdependent as they seek to ensure the effective operation of the local campus.

An important corollary of interdependence is the potential for conflict that tends to accompany it. As the level of interdependence and need for coordination among sub-units in an organization increases, so does the potential and likelihood of conflict. Other interactions are characterized and presented in Exhibit 1-4.

(c) Content of Interactions

Finally, OD theory directs attention to the content of the interactions among the actors: the information system itself. Experience and research indicate that information has an important impact on the distribution of authority in organizations. To the degree that information is the basis for decision-making, control of and access to information represents power. Characterization of an EDP facility as a scarce resource identifies its control as another means of accruing power in organizations.

Power is a "fact of life" in any organization. The explicit identification of this aspect of information systems provides insight into the extraordinary energy often exhibited by parties reacting to EDP development. Ironically, the lack of awareness of power as the hidden content of interactions often limits the ability of the organization to de-fuse the intensity of disagreements or disruption.

Integration of MIS Predictions and OD Theory

As is noted in Exhibits I-2, -3, and -4, there is significant overlap in the principles generated by OD theory and the collected wisdom of experts in information systems. Predictions 2, 3, 4, 6, 11-14, 16-18, 21, 23, 24, 25, 29, 31, and 32 are noted as important issues

Exhibit I-4: Summary of Concepts Pertaining to Interactions

Interactions/Concepts

Predictions from MIS Literature*

(1), (2), and (3)
The major characteristic of these interactions is the high level of interdependence.

The higher level of interdependence that requires mutual adjustment, the higher the necessity for coordination and the greater the likelihood of conflict.

Conflict may be either constructive or destructive.

(4)

The major characteristic is the superior/subordinate nature of the relationship.

Key issues are identification of mechanisms for promotion/evaluation, definition of areas of responsibilities and allocation of tools for the accomplishment of tasks.

(5)

The presence of a scarce resource requires explicit attention to the allocations of that resource and to the assignment of decision authorities with regard to that resource.

(6), (7), and (8)

Differences in norms will engender differences in expectations and must be explicitly explored.

(9)

The level of interdependence determines the criticality of the interaction. Independence minimizes concern.

(10)

See Environment discussion under Actors

Different types of educational institutions interact with different actors in the external environment.

14, Organizational contingencies

* See Exhibit I-1, pp. 3-5.

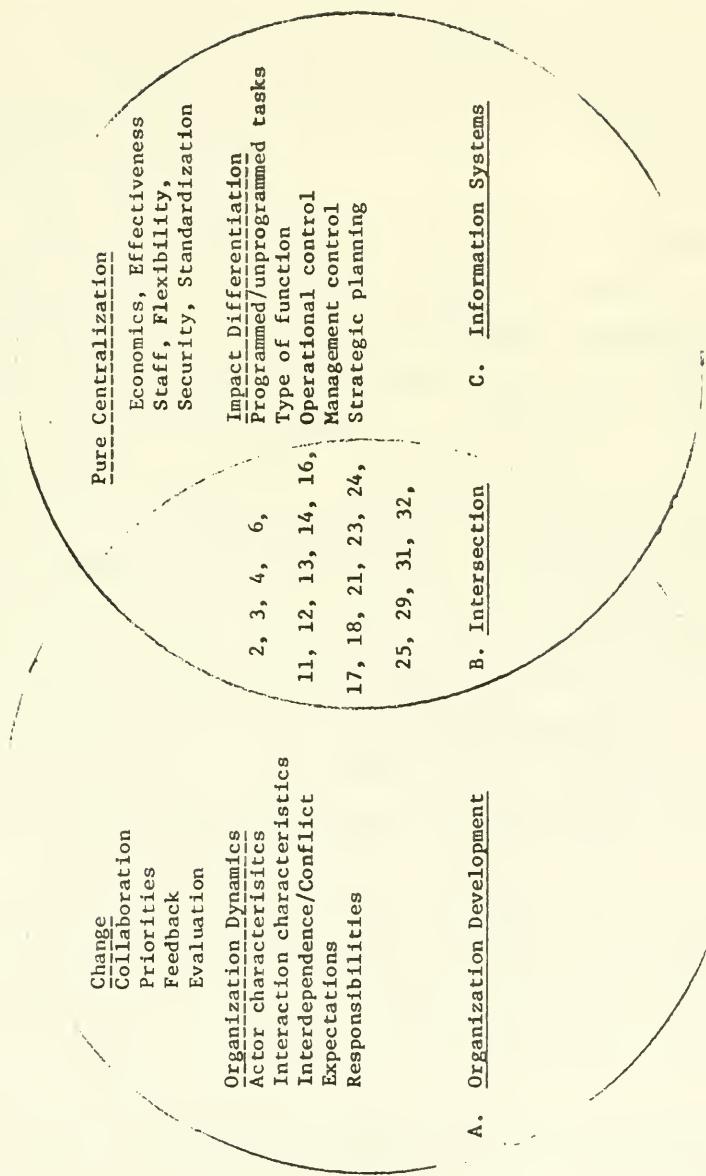
24, Increased communication and coordination needs (centralized)

by both fields.

The contribution of OD concepts and models is the systemization of the predictions of the MIS literature. Rather than the essentially random checklist presented by the literature, OD theory focuses on four basic concepts: the process of change, characteristics of actors, nature of interactions among actors, and substance of these interactions. Mapping the intersection of these two fields brings us closer to outlining specific guidelines for affecting the organizational impacts of EDP development.

Exhibit I-5 presents the intersection and union of the two fields. The intersection issues are indentified by the numbers of the predictions from Exhibit I-1. Additional insights offered by organization development and information systems are noted in the remaining portions of each circles. To fully appreciate the complexity of the impacts, especially that of centralizing EDP operations, not only the issues identified by both fields must be considered, but also those which are specific to each--the particular considerations of centralized DP operations, and the internal dynamics of organization, the setting in which EDP operations live and are presumed to serve.

Specifically organization development draws attention to the distinction between a process of change and impacts on organization dynamics. Within the change model, specific attention is focused on the collaborative nature of the effort, the need to establish priorities, the need for feedback, and for evaluative mechanisms. Particularly critical to organization impacts are the issues of interdependence (which are often the root of conflict over change in organizations), the need to understand the widely-differing expectations of the actors involved, and the need to assign clear responsibilities among actors.



In addition to the issues noted in the intersection, the information systems literature draws attention to issues which pertain to centralized systems: economies of scale, effectiveness, questions of staff responsiveness and flexibility, data security and disruptions caused by standardization. It also focuses on two means of differentiating likely impacts: the nature of decisions - programmed or unprogrammed, and the types of management function involved - operational control, management control, or strategic planning.

Thus, by drawing on the two fields we are able to generate a framework for assessing the organizational impacts of computer systems which is based on theory and is comprehensive enough to encompass the full range of organizational issues raised by major changes in computer systems. The framework involves segments A and B of Exhibit I-5. The theory provides the basis not only for management action and decision-making, but it also identifies areas where there are gaps in our knowledge and rank-orders those gaps to provide a systematic approach for choosing fruitful topics for further research. Most important, a systematic approach to dealing with the organizational issues of section B has been described. The approach can be used either for retrospective analysis -- as is done in the next section -- or, more importantly for prospective efforts to avoid organizational problems with the centralization of computer systems.

However, thus far we fall prey to the same accusation of macro-level generalization which was levelled at the experts in the introductory paragraphs of this report. Let us now turn to a more concrete and specific case of the situation for which this framework has been developed.

III. Field Study of Centralization: An Example from Higher Education

The field study was conducted in an organization currently centralizing its EDP operations. The organization is a ten-campus public college

effort to centralize data processing for the colleges (local sites) in 1973 after a year of self-study and system evaluation. The study focussed on the manner in which the process of change was managed and seven questions which directly address organizational issues of centralized systems.

A detailed description of the organization, its computer systems both prior and proposed, and the method for collecting data are contained in the full report of this research project. The analysis is based on data from forty-four interviews and sixty-five questionnaires. The details of the analysis and tabulations of specific questionnaire items are presented in the full report.

A summary of the results of the analysis is presented below in two sections: (a) an analysis of the process of change, and (b) an analysis of the impacts of the centralized system on internal organization dynamics.

A. Change Process

At the study site, dissatisfaction with the information system centralization process revolved primarily around difficulties which arose as a result of the management of the change process itself, rather than the specific characteristics of the centralized system. Using the model of change presented earlier, the bases for some of the difficulties can be identified and traced to specific stages.

Entry. Inadequate clarification of the responsibilities of the central computer staff produced considerable discomfort and resulted in unmet expectations on the part of local administrators and defensiveness on the part of the staff. Both reactions contributed to a climate somewhat less than conducive to productive problem-solving behavior during the first year of operations.

Diagnosis. The nature of the process of initially defining needs for the organization directed attention solely to the new computer system, and ignored needs for non-computer related management training which

existed at several of the campuses. The diagnostic stage for a computer system installation must involve a broad-based assessment of organization needs.

Planning. Insufficient consultation, and the extraordinary time pressures which surrounded the development of the first application program shared by all campuses, resulted in dissatisfaction among admissions officers, directors, and others dependent upon that system. The time pressure, in particular, precluded some pre-testing which might have surfaced bugs which appeared later.

Since the initial system, major changes in the approach to application program development have ameliorated the difficulties and level of tensions considerably. Both staff and local administrators expect more rewarding and productive interactions in the development of succeeding application programs with increased user involvement.

B. Internal Organization Dynamics

Assessment of the impacts of the centralized system on the organization focussed on seven questions drawn from the MIS literature, explored in depth by the questionnaire and through interviews. These questions were:

Can a centrally-located staff meet local user needs?

How does the centralization affect individual jobs on a daily basis?

What function is the central computer staff viewed as serving?

How do people view the potential impact of the centralized system on decision-making?

Do people feel their autonomy and control threatened by the central staff?

What are the overall reactions to centralization?

Can we identify characteristics of those who oppose and those who accept the centralized system?

Major findings from the field study data parallel those issues indicated

as most critical by the organization development framework outlined in part III. Three of the four major findings are described within the three-part framework: actors, interactions, and content of interactions.

(1) Individual Actors: Perceptions of Loss of Autonomy

In general, local administrators are not concerned about losing control of inputs needed to accomplish their tasks on a day-to-day basis. However, those administrators who would be most affected if shared application systems were standardized (as often occurs with centralization) perceived major threats to their autonomy and reacted accordingly. These negative responses reflected concerns with perceived intentions to standardize application programming which involved grading and class scheduling, two areas where there are dramatic and important differences from campus to campus.

(2) Interactions: Interdependence

There are several components to the interdependence issues. The components have been identified by defining interdependence as the sum of several mutually-dependent relationships between the local sites and the central computer staff.

(a) Interim systems. The development of shared application programs for the campus system is scheduled to be completed in 1979. Between now and then interim systems must be developed for local campuses. A major problem occurred where local campuses were relatively unsophisticated and therefore dependent on the central computer staff for the development of these interim systems. The central staff was not equipped to meet these demands. As a result there was great tension, and reactions to the centralized system tended to be negative at these campuses. Where local campuses were able to develop interim systems on their own, i.e., independent of the central staff, and thus exploit the new computer system, reactions tended to be positive.

(b) Shared application programs. In order to develop application systems for the campuses which adequately serve local needs, the central computer staff is dependent upon local campuses to describe and define the parameters of their needs. This tends to be an iterative, time-consuming process which creates a great deal of tension for those involved.

(c) Reliability. The local site which reacted most negatively to the centralization of the computer system was that campus which is most dependent upon computer support (in an absolute sense). Reactions to the centralization were extremely negative at this campus and appeared to reflect concerns about potential system failures.

Thus, the interdependence which is a corollary of centralized computer systems, significantly increased the level of tension and potential for conflict throughout this organization. By using the OD framework it is possible to identify the specific causes of the tension and conflict, and thus permit management to take remedial steps (in this case) or to anticipate such reactions (in other organizations).

(3) Content of Interactions: Power

There was some difficulty eliciting specific predictions with regard to shifts in decision-making authority which might occur as a result of the new information system. There was evidence readily available that individuals are importantly concerned about this question, however. Those who reacted indicated concern that analytic information which might be available as the new system developed and was capable of providing central office administrators with data for inter-campus comparisons, might lead to a centralization of decisions regarding the development of academic programs.

(4) Political Factors

Using the OD framework it is possible to identify and categorize many of the responses to the centralized computer system. There are other factors which appear to temper responses to the system, however. Included under the rubric of "political factors" are the reactions of influential individuals, general organization climate, and local norms and politics. The specifics of these factors are not readily accessible to the outside observer; their impact, however, is unmistakable.

C. Comment on the Field Study Findings

Many of the difficulties this organization encountered were the result of the process by which the change was managed as well as the consequences of the nature of a centralized computer facility. The impacts of the two are not separate phenomenon, however. The three components of the situation- actors, interactions, and content - all interact during a change effort, contributing singly, collectively, and synergistically to the process. In reviewing the findings several general principles for action can be identified.

Some of the forces operant in the situation cannot be changed. Organization norms, the members and setting and sub-units, and apparently the inherently apprehension-producing nature of centralized computer systems must be accepted as baseline conditions of the organization.

No amount of anticipation or design will allay all apprehension or dissolve every potential conflict. Fear, tension, and conflict are corollaries of change. Their consequences can be either constructive or destructive, and the outcome is totally dependent on a willingness to confront and deal with their appearance.

Many potential negative forces can be significantly ameliorated. While inherent actor characteristics cannot be modified, attitudes and perceptions can be changed. Choices can be made with regard to the design of the change

process and with regard to the composition of the team which manages it.

While the latent content of information systems development remains, intentions with respect to the use of the information and systems can be made more explicit thereby lessening the effect of potentially damaging rumors.

The process of choosing, designing, and implementing a computer based information system is extremely complex. However, it is sensitive and responsive, despite the complexity, to pressures exerted on a number of its components. Management can affect quality and outcomes of the process in a variety of ways.

IV. General Implications for Management

There are three basic courses of action open to management:

-management can actively design processes to affect those factors and contingencies over which there can be some control.

-management can become as knowledgeable as possible about those contingencies over which there can be less direct control, but to which the organization must be prepared to react constructively, and

-management can seek expert assistance in negotiating the morass of organizational issues which computer system development raises.

A. For the factors which management can directly affect, there are two specific actions which can be recommended:

(1) The design and management of the process of change is a major mechanism for affecting the quality of the organizational impacts of an EDP development effort. The model presented in Exhibit I-2 has been utilized in a wide variety of settings and is, perhaps, the clearest set of recommendations that can be made to top management. Most, if not all of the issues identified in the model can be directly affected by top management action, either by choice of leadership for the change process or by explicit commitment of time and resources to such a process.

(2) Change creates tension and stress in organizations. Centralization and dependence upon computer facilities exacerbates that stress. Specific attention to the preparation of individuals in the organization to deal with the conflict that accompanies stress and to interact productively in problem-solving activities is a second major mechanism available to management for improving the outcomes of EDP development efforts.

This can be accomplished in a number of ways. Like the management of change, conflict management is a field within organization development and there are techniques for training individuals to improve skills in problem-solving behavior and conflict resolution. Top management can invest in training for itself, for the team that will manage the conversion or for a segment of the organization that will be involved. Alternatively, or in addition, distribution of some of the brief and relevant books available on the subject would be a valuable investment.

B. For those contingencies and factors over which there can be less control management can take steps to prepare its organization to react constructively. The following steps can be taken:

(1) An accurate description of the organization - the actors, their characteristics and roles, the interactions among actors, their relationships and inter-dependencies - are vital to anticipating the impacts of an EDP effort on the organization. This type of diagnosis can be accomplished by a team within an organization, systematically assessing sub-units of the organization from the perspectives outlined in part II of this paper.

(2) In addition, it is critically important that all members of the organization responsible for the installation of a new computer facility - centralized or not - be cognizant of the role of information in the organization. Information is a major determinant of the distribution of power and authority in organizations and changes which involve information

systems will meet with the intensity of reaction accorded to such changes.

Self-conscious action with regard to the nature of an information system conversion can importantly increase the ability of the organization to promote a problem-solving, constructive climate, rather than one which is threatening to organization members, or encourages defensive behavior.

C. In general, both the literature and the case study findings suggest that management cannot be expected to act alone to prepare an organization for the impacts of a major system conversion. The aid of a consultant, external or internal, is essential. Like the theoretical approach presented here, diagnosis and preparation for reactions to a major conversion require collaboration among specialists in three areas: information systems, organization behavior, and the specific organization in question. Only a team whose expertise addresses the full range of organization-wide repercussions can produce an analysis or a plan whose potential matches the complexity of the problem.

Finally, it is quite clear that the accuracy of this analysis and the range of recommendations which can be made to management are limited by the state of knowledge in information systems and organization behavior. It must be called to the attention of management that there is a need for support of research in these fields from which guidelines for effective management action can be drawn.

In the technical areas of information systems development, management has provided generous support for many years. It is clear at this point, that technical sophistication is insufficient for the development of computer-based information systems which effectively support the needs of organizations. Support for research on the organizational impacts of information systems is a key to developing further.

The research requires heavy investments of professional time and the

location of organizations willing to participate. Management can choose whether to support the time of those involved through direct funding, or to offer their organizations as research sites. To the degree that top management wishes to see progress in and to benefit from the development of data processing systems which increase, rather than diminish, the overall health and effectiveness of organizations, management has an interest in supporting research which is aimed at elaborating the organizational factors outlined in this report.

Conclusions

Technical developments in information systems have been rapid and dramatic over the past decade. Yet there are still major questions to be answered about the relative merits of centralized versus decentralized system configurations. Much of the inability to address these questions can be traced to inadequately assessed organizational impacts. These impacts need no longer be a black box to management.

Problems associated with organizational impacts are complex and their solution requires a comprehensive approach. There is, however, a rich source of information and expertise in organization development presently available to management for application to EDP-related organizational problems. It is the purpose of this report to demonstrate to management that there is a framework which management can use to assess these impacts, and specific actions which management can take to improve the organization effectiveness of computer-based management systems. To ignore this resource is to make a conscious decision to limit the effectiveness of computer-based information systems, and ultimately, the effectiveness of organizations themselves.

Chapter I - References

Anthony, R.H., 1965. Planning and Control Systems: A Framework for Analysis. Harvard University Graduate School of Business Administration.

Argyris, Chris, 1971. "Management Information Systems: The Challenge to Rationality and Emotionality." Management Science, 17(6): B275-B292.

Canning, Richard G., (ed.), August 1973. "In Your Future: Distributed Systems?" in EDP Analyzer 11(8): 1-13

Dearden, John, May-June, 1966. "Myth of Real-time Management Information," Harvard Business Review, pp. 123-131.

Gibson, Cyrus F., and Richard L. Nolan, 1973. "Organizational Issues in the Stages of EDP Growth," Data Base 5 (2,3,4): pp. 50-62.

Glaser, George, 1973. "The Centralization vs. Decentralization Issue. Arguments, Alternatives and Guidelines." Data Base, a Quarterly Newsletter of the Special Interest Group on Business Data Processing, 2 (3): 1-7.

Gorry, G. Anthony and Michael S. Scott Morton, Fall 1971. "A Framework for Management Information Systems," Sloan Management Review, vol. 13, no. 1, pp. 55-70.

Heany, Donald F., 1972. "Education: The Critical Link in Getting Managers to Use Management Systems," Interface, vol. 2, no. 3, pp. 1-7.

Hofer, Charles W., 1970. "Emerging EDP Pattern," Harvard Business Review, March-April, pp. 16-31.

Huysmans, Jan H. 1973. Operations Research Implementation and The Practice of Management. Conference on the Implementation of OR/MS Models. (November 1973) University of Pittsburgh,

Kolb, David A. and Alan L. Frohman, 1970. Organization Development through Planned Change: A Development Model, Sloan School of Management Working Paper (Cambridge, Mass.: MIT).

Leavitt, Harold and Thomas L. Whisler, 1958. "Management in the 1980's," Harvard Business Review, 36, no. 6, 41-48.

Lucas, Henry C.,Jr., 1973. "A Descriptive Model of Information Systems in the Context of the Organization," Data Base, 5 (2,3,4): 27-36.

Lucas, Henry C., Jr., 1973b. "Behavioral Factors in System Implementation," Research Paper #188, Graduate School of Business, Stanford University.

MacGregor, Douglas, 1960. The Human Side of Enterprise, (New York: McGraw - Hill).

Manley, John H., 1973. "Implementation Attitudes: A Model and a Measurement Methodology," Paper presented to the Conference on the Implementation of OR/MS Models, University of Pittsburgh.

McKinsey & Co., 1968. Unlocking the Computer's Profit Potential.

Norton, David P., 1973. "Organizing for the Computer: To Centralize Or Not to Centralize," unpublished manuscript, Cambridge, Mass.: Index Systems, September 20.

Rubenstein, Albert H., Michael Radnor, Norman R. Baker, David R. Heiman and John B. McColly, 1967. "Some Organizational Factors Related to the Effectiveness of Management Science Groups in Industry," Management Science 13 (8): B508-B518.

Schein, Edgar H., 1970. "The Reluctant Professor: Implications for University Management," Sloan Management Review, Fall, 33-49.

Streeter, 1973. "Centralization or Dispersion of Computing Facilities," IBM Systems Journal, No. 3.

Urban, Glen L., March 1972. An Emerging Process of Building Models for Management Decision-Makers. Sloan Working Paper, 591-72, Sloan School of Management (Cambridge, Mass.: MIT).

Whisler, Thomas L., 1967. "The Impact of Information Technology on Organizational Control," in Myers, Charles A. (ed.), The Impact of Computers on Management (Cambridge, Mass.: MIT Press), pp.16-60.

Whisler, Thomas L., 1970. The Impact of Computers on Organizations, Praeger Publishers, New York.

